



MEMORANDUM

SUBJECT: Updated information on air quality monitoring data for thoracic coarse particles used in epidemiologic studies

FROM: Mary Ross, Health Scientist *Mary Ross*

TO: PM NAAQS Review Docket (OAR-2001-0017)

DATE: June 30, 2005

This memorandum provides information on the distribution of $PM_{10-2.5}$ measurements across a number of urban areas in which epidemiologic studies have been conducted. The purpose of this assessment is to inform staff's evaluation of the epidemiologic evidence on $PM_{10-2.5}$ -related health effects, as discussed in Chapter 5 of the Staff Paper (EPA, 2005).

An earlier memorandum discussed a preliminary staff evaluation of $PM_{10-2.5}$ concentrations in the Detroit area (Ross and Langstaff, 2005). As discussed there, in evaluating ambient air quality data from cities used in the health risk assessment, staff observed substantial differences between concentrations from recent years in Detroit with those reported from the study period. This prompted further assessment to compare $PM_{10-2.5}$ measurements obtained for recent years from monitoring stations in and around Detroit, including those in nearby Windsor, Ontario, where the $PM_{10-2.5}$ concentrations used in the study were measured.¹

This assessment of $PM_{10-2.5}$ measurements has been extended to include several additional urban areas in which epidemiologic studies have been conducted: Coachella Valley, CA; Phoenix, AZ; Seattle, WA; St. Louis, MO; and Steubenville, OH. Attachment A includes observations on the $PM_{10-2.5}$ concentrations reported in epidemiologic studies conducted in these cities and $PM_{10-2.5}$ measurements from more recent years.

Attachments

¹ This discussion has also been included in this memorandum in Attachment B.

References:

EPA (2004) Air Quality Criteria for Particulate Matter. Research Triangle Park, NC: National Center for Environmental Assessment-RTP Office; report no. EPA/600/P-99/002aD.

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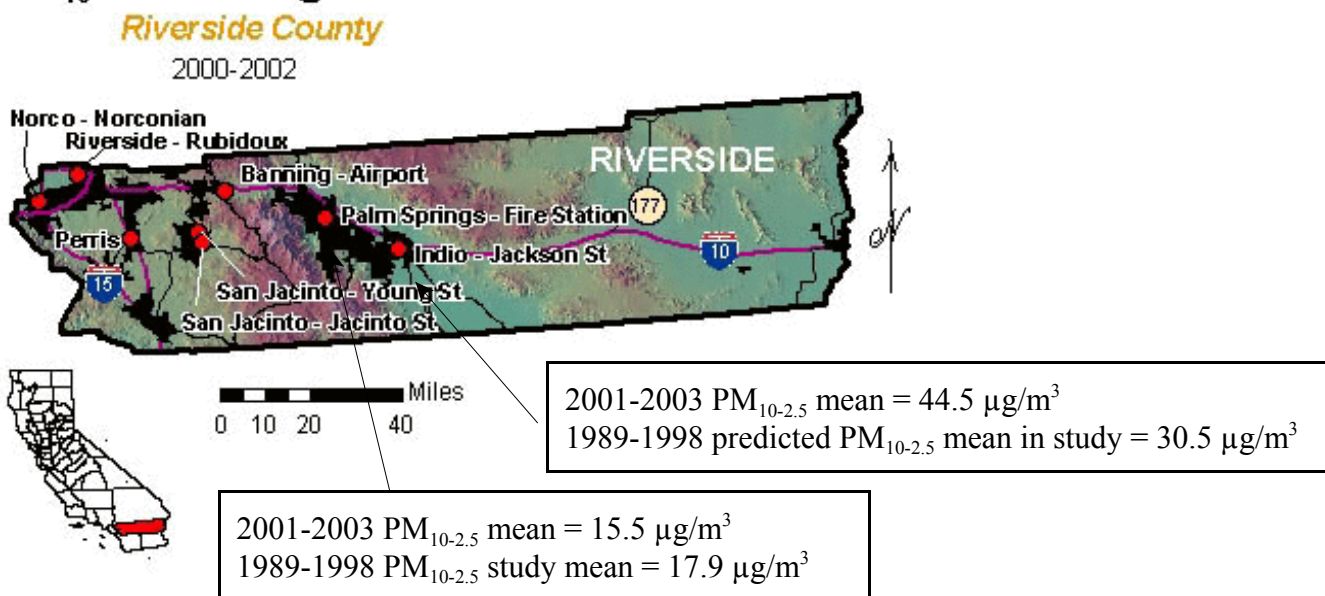
Sheppard, L.; Levy, D.; Norris, G.; Larson, T. V.; Koenig, J. Q. (1999) Effects of ambient air pollution on nonelderly asthma hospital admissions in Seattle, Washington, 1987-1994. *Epidemiology* 10: 23-30.

Spengler, J.D.; Briggs, S.L.K.; Ozkaynak, H. (1986) Relationships between TSP measurements and size-fractionated particle mass measurements in six cities participating in the Harvard Air Pollution Health Study. Report prepared for Office of Air Quality Planning and Standards, Environmental Protection Agency, EPA Cooperative Agreement #CR-812667-01-0. December 5, 1986.

ATTACHMENT A

1. Observations on $PM_{10-2.5}$ Concentrations From Monitoring Sites in Coachella Valley, CA

PM_{10} Monitoring Stations



Map source: <http://www.arb.ca.gov/adam/mapfiles/rivpm10.html>

For an epidemiologic study, $PM_{10-2.5}$ data were obtained from monitors located at two cities in the Coachella Valley, Palm Springs and Indio; the authors report that the correlation coefficient for data at these two sites was 0.61 (Ostro et al., 2000, p. 414). Measurements made at Indio (from beta attenuation monitors for PM_{10} and $PM_{2.5}$) were used in the analyses, and mortality data were from both communities (discussed more fully in Ostro et al., 2000). As shown on the map above, both the 2001-2003 mean design value and the study-period mean $PM_{10-2.5}$ concentrations were substantially (two- to three-fold) higher at the Indio site than the Palm Springs site. The measurements made at the Indio site may thus be overestimates of ambient $PM_{10-2.5}$ concentrations for Coachella Valley residents in the Palm Springs area.

This is consistent with data for both PM_{10} and $PM_{2.5}$, as shown in the 2003 Air Quality Management Plan for the South Coast Air Quality Management District (<http://www.aqmd.gov/aqmp/AQMD03AQMP.htm>.) In this report, it is observed that Palm Springs is closer to the mountain ridge and is more sheltered from high winds, and is generally upwind of most Coachella Valley fugitive dust sources. The monitoring site at Indio is downwind and east of Palm Springs (2003 Coachella Valley PM_{10} State Implementation Plan, 2003 <http://www.aqmd.gov/aqmp/docs/f2003cvsip.pdf>).

2. Observations on PM_{10-2.5} Concentrations From Monitoring Sites in Phoenix Area

An epidemiologic study on mortality used air quality data collected at an EPA research monitoring station that operated from 1995-1997 (Mar et al., 2000; CD, p. 8-58). Staff have obtained more recent data from the same monitoring location (West Phoenix) and an additional site nearby (JLG Supersite). The locations of these two ambient air monitoring stations are shown in the attached map (marked with stars) as part of the larger monitoring network for all criteria pollutants in Maricopa County.

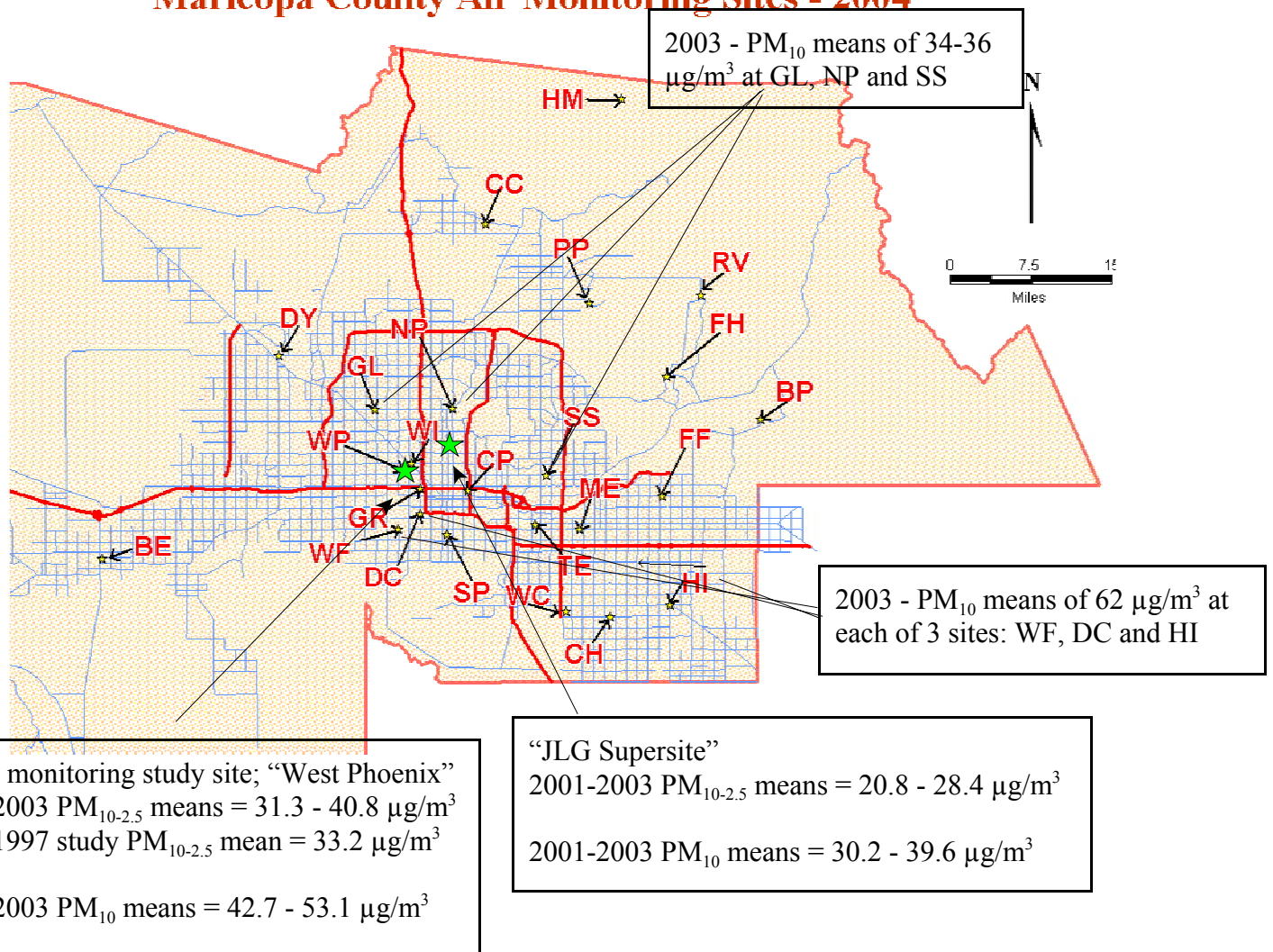
The mean PM_{10-2.5} concentrations from these two monitors are shown in Table A-1 for several recent years. PM_{10-2.5} concentrations at the West Phoenix site are substantially higher than those at the JLG supersite; data used in the epidemiologic studies were obtained at the West Phoenix site. Correlation coefficients between measurements at these two sites range from 0.87 to 0.94 over 2001-2003, indicating that the ambient PM_{10-2.5} measurements are highly correlated on a temporal basis at these sites.

Table A-1. Annual mean PM_{10-2.5} concentrations from monitors in Maricopa County, AZ (in µg/m³)

Site code	Site name	2001	2002	2003
0019	West Phoenix	31.3	40.8	36.6
9997	JLG Supersite	20.8	22.6	28.4

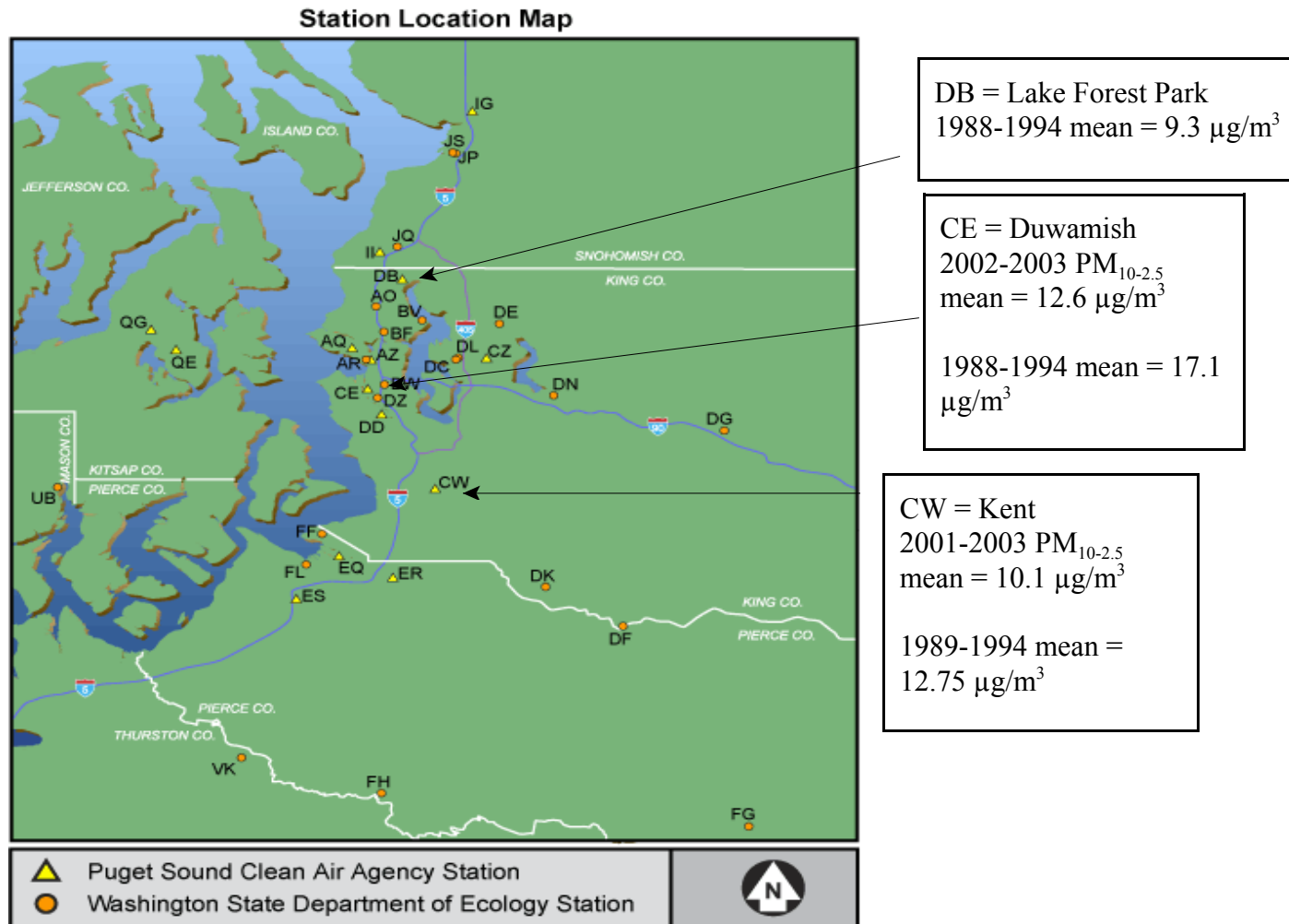
In addition, there are 14 PM₁₀ monitors in the Phoenix area that can provide some insight into the variation in thoracic coarse particle concentrations across the region. PM₁₀ concentrations range from generally lower levels (means of about 35 µg/m³ and maximum levels of over 170 µg/m³) on the north side of the city to generally higher levels to the south (means of up to 62 µg/m³ and maximum levels of well over 200 µg/m³). The mean PM₁₀ concentration at the West Phoenix site was 46 µg/m³ in 2003, which suggests that PM_{10-2.5} concentrations reported for this particular site are in the middle of the range of concentrations across the Phoenix area. PM_{2.5} mean concentrations for 2001-2003 ranged from only about 9 to 12 µg/m³.

Maricopa County Air Monitoring Sites - 2004



Map source: http://www.maricopa.gov/sbeap/AIR_MONI.HTM

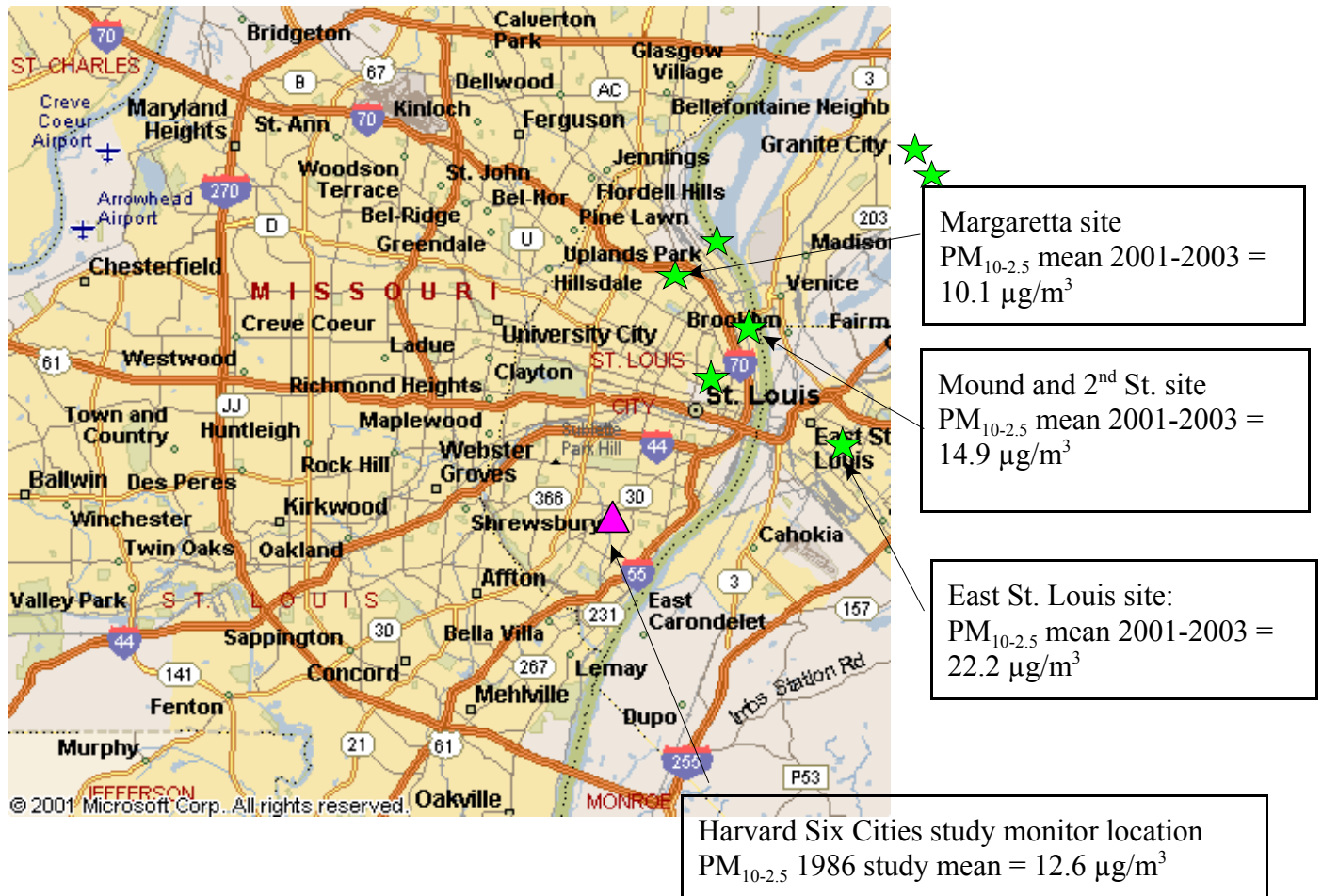
3. Observations on $PM_{10-2.5}$ Concentrations From Monitoring Sites in Seattle, WA



Sheppard et al. (2000) used PM_{10} and $PM_{2.5}$ from three monitoring locations (indicated above). The concentrations were determined as weighted averages, with greater weight on data from the residential sites than the industrial site (Duwamish). $PM_{10-2.5}$ was calculated as the difference between the concentrations from gravimetric measurements of PM_{10} and $PM_{2.5}$ at the Duwamish and Kent sites (at Lake Forest Park, $PM_{2.5}$ mass was estimated from nephelometry measurements). For the study period, 1987-1994, the mean $PM_{10-2.5}$ concentration was $16.2 \mu\text{g}/\text{m}^3$; $PM_{10-2.5}$ concentrations at individual monitors ranged from 9.3 to $17.1 \mu\text{g}/\text{m}^3$ during this time period. The 2001-2003 design value mean concentrations are lower, with $PM_{10-2.5}$ levels of 12.6 and $10.1 \mu\text{g}/\text{m}^3$ at the Kent and Duwamish monitors, respectively. This is consistent with the pattern of reductions seen in PM_{10} concentrations through the mid-1990's.²

² see 2003 Air Quality Data Summary, Puget Sound Clean Air Agency, <http://www.pscleanair.org/ds03/docs/PDF2003/2003AQDSFinal.pdf>, p. 41

4. Observations on $PM_{10-2.5}$ Concentrations From Monitoring Sites in St. Louis, MO

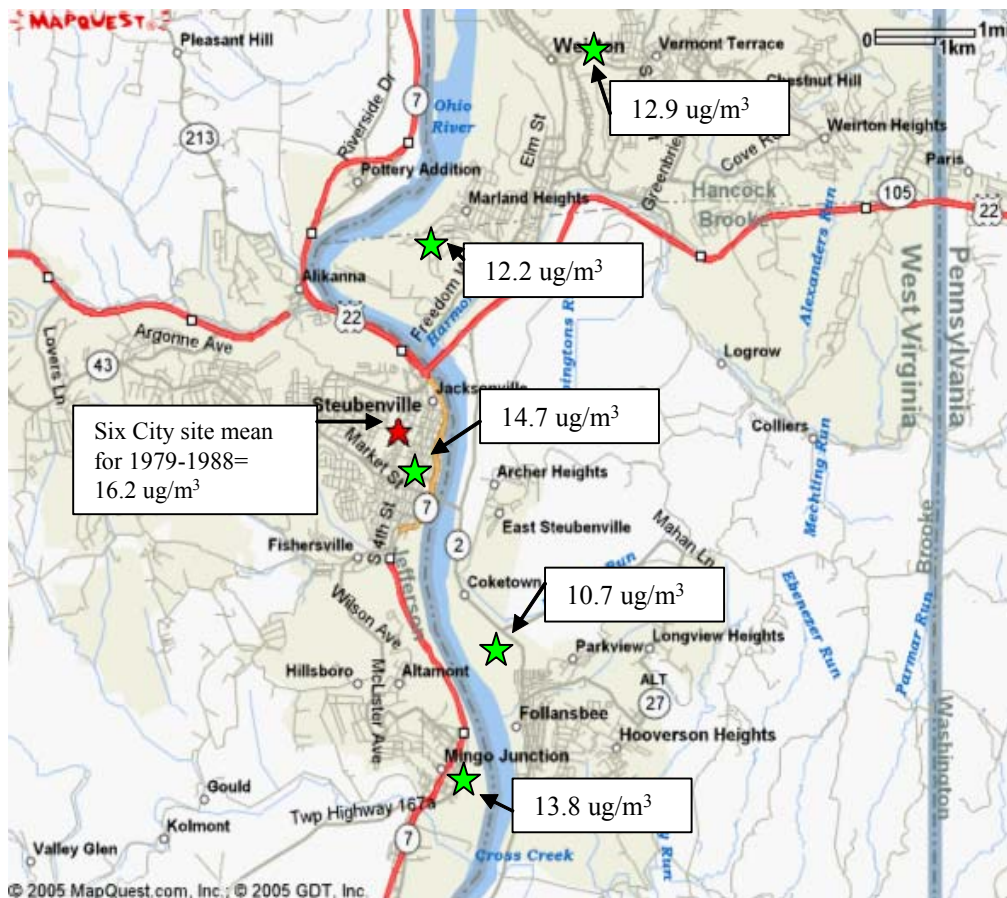


The Harvard Six Study monitoring site was described as “SE section of industrialized metropolitan city of 425,000” and “site located in residential/light commercial area, bordered by railroad tracks and adjacent to unpaved parking lot” (Spengler et al., 1986, p. 21). Based on the latitude and longitude coordinates provided, the monitoring site is marked by the pink triangle.

For the full Six Cities study period (1978-1987) the mean $PM_{10-2.5}$ concentration was $11.9 \mu\text{g}/\text{m}^3$. During the time period (April to August 1986) during which the respiratory symptoms panel study was conducted (Schwartz et al., 1994), the mean $PM_{10-2.5}$ concentration was $12.6 \mu\text{g}/\text{m}^3$. Using 2001-2003 data, the $PM_{10-2.5}$ design value mean concentrations at two monitors located in St. Louis were $10.1 \mu\text{g}/\text{m}^3$ and $14.9 \mu\text{g}/\text{m}^3$. The $PM_{10-2.5}$ design value mean concentration at the East St. Louis, IL site is substantially larger ($22.2 \mu\text{g}/\text{m}^3$) than those reported in St. Louis city. $PM_{10-2.5}$ measurements made at the Harvard Six Cities monitor would appear to be similar to levels in other areas of the St. Louis area, but lower than concentrations reported in areas on the Illinois part of the metropolitan area.

5. Observations on $PM_{10-2.5}$ Concentrations From Monitoring Sites in Steubenville, OH

The Harvard Six Cities measurements were made in 1979-1988, and the overall $PM_{10-2.5}$ study mean in Steubenville was $16.1 \mu\text{g}/\text{m}^3$ (Schwartz et al., 1996). Design value mean concentrations from 2001-2003 are presented on the figure below for several monitoring sites in the Steubenville area (shown as green stars). The mean concentrations range from 10.7 to $14.7 \mu\text{g}/\text{m}^3$, with the highest level at the central city monitor that is closest to the site of the Harvard Six Cities study monitor. Correlation coefficients between $PM_{10-2.5}$ measurements at the central Steubenville site and three other area sites (using 2000-2001 data) ranged from 0.64 to 0.69 (EPA, 2004, Appendix 3A).



ATTACHMENT B

PM_{10-2.5} Concentrations From Monitoring Sites in Detroit Area³

In developing the PM health risk assessment, air quality data were obtained for several recent years for each of the cities included in the assessment. One component of the health risk assessment was evaluation of the air quality data available for recent years and comparison of these data with levels reported in the studies (see Chapter 4 in Staff Paper). One such epidemiologic study used ambient measurements from two dichotomous samplers located in Windsor, Canada, for the time period 1992 through 1994 in a study of hospital admissions in Detroit (Lippmann et al., 2000; Ito, 2003). In looking at PM_{10-2.5} data from Detroit, staff observed that the PM_{10-2.5} concentrations at the two central city monitoring stations (Dearborn and West Fort) in recent years were substantially higher than those from the Windsor monitors in 1992-1994. The average concentration for the two Detroit monitors in 2003 was 21.7 µg/m³, while the mean concentration at the Windsor monitors in 1992-1994 was 13.3 µg/m³. This observation prompted further exploration of PM_{10-2.5} concentrations reported from the Windsor and Detroit area monitors.

The Windsor monitors are located directly across from the Detroit central city area, as shown in the map below (Figure B-1). The authors did extensive evaluation of the available air quality data, as described in the initial study report. PM₁₀ concentrations from eight monitoring sites in the area were found to be highly correlated, with a median correlation coefficient of 0.78 (Lippmann et al., 2000, p. 14). More detailed analyses used data from the numerous TSP monitors located across the Detroit area, including the Windsor monitoring stations. The authors found that the concentrations were highly correlated, and concluded that “the Windsor site was as good as any other sites in the area in terms of representing the population TSP exposure for the Detroit metropolitan area” (Lippmann et al., 2000, p. 20). The authors observed, in addition, that the magnitude of the TSP concentrations varied, with mean concentrations varied by a factor of two; concentrations were generally higher at the central city sites than in “upwind” areas west of the city (Lippmann et al., 2000, p. 20).

Figure B-1 also includes locations of all air pollution monitoring stations in the Wayne County area (which includes Detroit). Particulate matter concentrations have been measured at 4 of these sites – Allen Park, Dearborn, West Fort, and Livonia – and these monitoring stations are marked by arrows. At each of these stations, the PM_{10-2.5} concentrations are determined by subtraction of PM₁₀ and PM_{2.5} concentrations.

PM_{10-2.5} data are not available from Wayne County during the epidemiologic study time period. However, PM_{10-2.5} data are available from the Windsor monitors for recent years, and thus can be used for comparison with PM_{10-2.5} concentrations from Wayne County monitoring stations. Table B-1 shows annual mean PM_{10-2.5} concentrations from Wayne County and Windsor stations

³This staff assessment was included as Attachment B to Ross and Langstaff (2005).

for 1999 through 2003. It can be seen that concentrations from the two central Detroit sites (Dearborn and West Fort) are appreciably higher, by about two- to three-fold, than those at the Windsor monitors. PM_{10-2.5} concentrations range around 20 µg/m³ in 1999-2002 at the two Detroit central sites (with more variable means of 11 and 30 µg/m³ in 2003), and from 4.5 to 11.1 µg/m³ at the Windsor monitor during the same time period. However, there are not such great differences between PM_{10-2.5} measurements made in Windsor from measurements at the two Wayne County monitoring stations located outside the city. In 1999-2002, mean PM_{10-2.5} concentrations at Allen Park (southwest of the city) range from 5.7 to 11.7 µg/m³ and at Livonia (northwest of the city) range from 6.8 to 8.7 µg/m³ (compared with 4.5 to 11.1 µg/m³ at the Windsor monitor).

Correlations have also been determined for daily concentrations of PM_{10-2.5} the same set of monitors. Appendix 3A of the CD reports correlation coefficients for the 1999-2001 time period for PM_{10-2.5} from the Dearborn, West Fort and Livonia sites that range from about 0.4 to 0.6, with the lowest correlation reported between the sites the greatest distance apart, West Fort and Livonia (CD, p. 3A-36). Using data from 1999-2000, staff found correlation coefficients of similar magnitude for paired comparisons of PM_{10-2.5} concentrations from the four Detroit and the Windsor sites, ranging from 0.4 to 0.75. Correlation coefficients for PM_{10-2.5} data from the Windsor with each of the Detroit area sites were in the range of 0.44 to 0.76. Correlation coefficients for comparisons between Detroit monitoring stations ranged from 0.4 to nearly 0.6; again, the lowest correlation coefficients were for the central Detroit sites with the northwest monitoring station at Livonia.

Table B-1. Annual mean PM_{10-2.5} concentrations from monitors in Wayne County, Michigan and Windsor, Ontario (in µg/m³)

Site code	Site name	1999	2000	2001	2002	2003
60211	Windsor (RDG dichot)	9.7	11.1	8.6	4.5	7.1
0025	Livonia	8.7	6.8	8.5	no data	no data
0001	Allen Park	15.3	11.0	11.7	5.7	8.2
0015	West Fort	21.6	18.6	23.5	18.0	11.6
0033	Dearborn	21.8	19.8	18.0	20.0	30.4

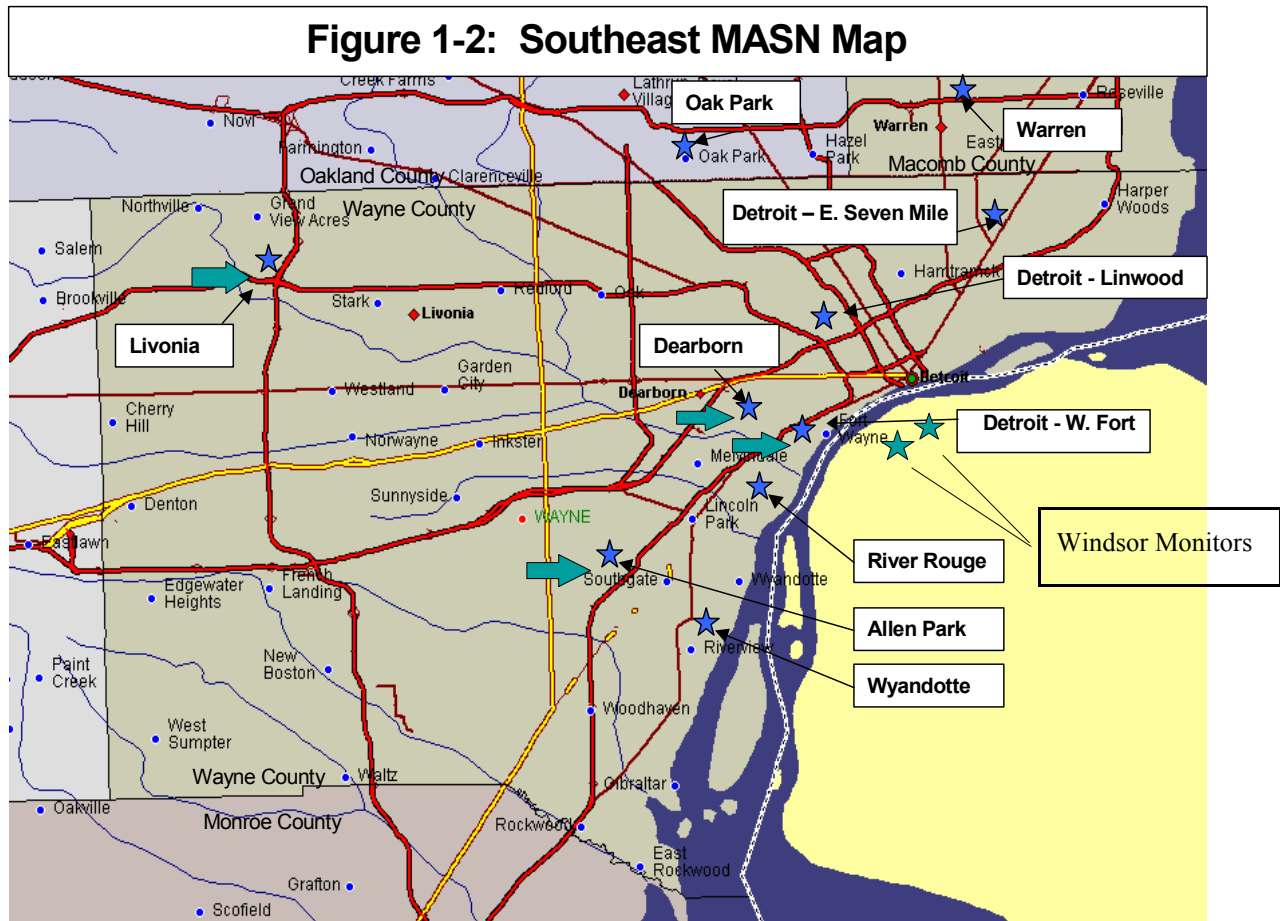


Figure B-1. Ambient air monitoring stations in the southeast region of the Michigan Air Sampling Network (MASN). The MASN monitoring stations that have included PM measurements are marked with arrows. In addition, the general locations of two monitoring stations in Windsor, Ontario, that have included PM measurements are marked “Windsor Monitors”. Source: Michigan’s 2003 Air Quality Report, Michigan Department of Environmental Quality, October 2004. [available at: http://www.michigan.gov/deq/0,1607,7-135-3310_4195-79055--,00.html]